AUV Rehearsal Tests for Fleet Battle Experiment - Hotel at the South Florida Ocean Measurement Center

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INTRODUCTION

The Office of Naval Research (ONR) Ocean, Atmosphere, and Space Science and Technology Department (Code 32OE) sponsored a demonstration of Autonomous Undersea Vehicle (AUV) technology at the South Florida Ocean Measurement Center (SFOMC), Ft. Lauderdale, Florida from June 5th - 16th, 2000. These demonstrations were conducted to test and evaluate AUV technology for naval mine countermeasures (MCM) missions in the Very Shallow Water/Surf Zone (VSW/SZ) regimes. The demonstration was in support of the Organic MCM Future Naval Capability (FNC) and was a dress rehearsal for ONR's participation in Fleet Battle Experiment-Hotel (FBE-H), a full-scale experiment designed to accelerate the maturation and transition of basic research by submitting it to rigorous, real world, operational usage by the Fleet.

The event featured small and lightweight AUVs from several groups, each with different and complementary missions within the overall MCM mission:

- Ocean Explorer and Morpheus, under development by Florida Atlantic University
- REMUS, under development by Woods Hole Oceanographic Institution
- Lockheed Martin's CETUS vehicle
- NAVSEA Panama City's Lemming tracked vehicle.

In addition to the vehicles, software developers from the Naval Postgraduate School and SAIC, representing the environmental and tactical modeling community, also participated. The first week of activity focused on allowing each vehicle practice time operating within the natural laboratory of SFOMC against a known, existing field of mine shapes and mine-like objects (MLOs). During the second week each group operated against a field of mine shapes and MLOs installed just for this event, the form and location of which were kept secret from the participants.

BACKGROUND

Preparations for this event started at the 2nd VSW/SW MCM Program Review held at Panama City, FL, December 14-16, 1999. At this meeting, SFOMC officials presented the facilities, assets, and infrastructure available to support AUV and crawler vehicle tests. Discussions at the Program Review among ONR, NAVSEA-Panama City, potential participants, and other stakeholders led to the conclusion that SFOMC was an ideal location to conduct the FBE-H dress rehearsal. The most significant factor in this decision was SFOMC's status as a natural, real-world laboratory. SFOMC combines a real world, operational Navy facility, with a densely populated field of real-time, high fidelity, and continuously operating, continuously accessible environmental sensors from the shoreline out to the 150-meter depth contour. SFOMC represents a real world environment, where a technology developer can expect to operate in an environment more rigorous and realistic than that achievable in any kind of laboratory, with a degree of environmental and boundary condition knowledge previously available only in a controlled laboratory situation.

While SFOMC took on the role of host site, NAVSEA-Panama City took on the role of Test Director and began developing the Test Plan. Pre-event collaboration between SFOMC, NAVSEA-Panama City, and ONR continued throughout the winter and spring resulting in three more major meetings:

- An all hands meeting held at SFOMC on February 23 and 24, 2000
- Another all hands meeting held at Corpus Christi, TX on April 25-27, 2000
- A final planning meeting between SFOMC and NAVSEA-Panama City on May 3, 2000

RANGE OVERVIEW

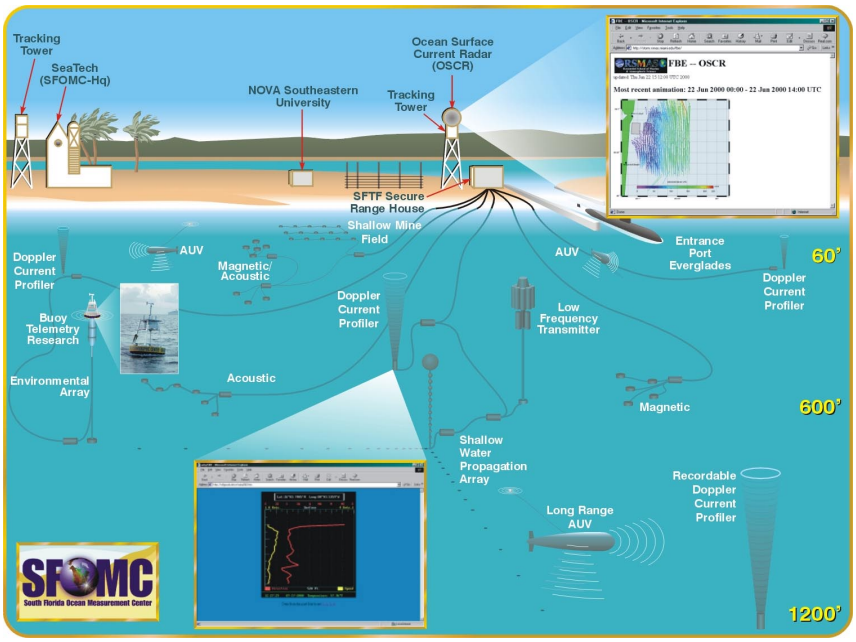

Figure1: SFOMC Range Overview

The SFOMC range lies southeast of Fort Lauderdale, Florida and the Port Everglades inlet. The range extends seaward from the shoreline to almost 2000 feet of water depth, approximately 22 miles offshore. Because it has supported numerous acoustics, magnetics, and other full-scale test programs, the range has developed into a multifaceted underwater sensor system with an array of real-time environmental sensors, cabling, instruments, and tracking systems. An overview is provided in Figure 1 and Figure 2 shows a chart of the existing minefield. Table 1 provides the details of the second minefield that was installed specifically for FBE-H tasking and Figure 3 shows some of the actual mine shapes.

Ground truthing for all mine-shapes, acoustic beacons, and other underwater support equipment was accomplished using differential GPS. Typically an SFOMC range support vessel would come alongside a buoy marking an underwater object on a short tether. After placing the vessel and its GPS antenna nearest and adjacent to the buoy, multiple fixes or positions would be taken to precisely determine the position of the mine or other object.

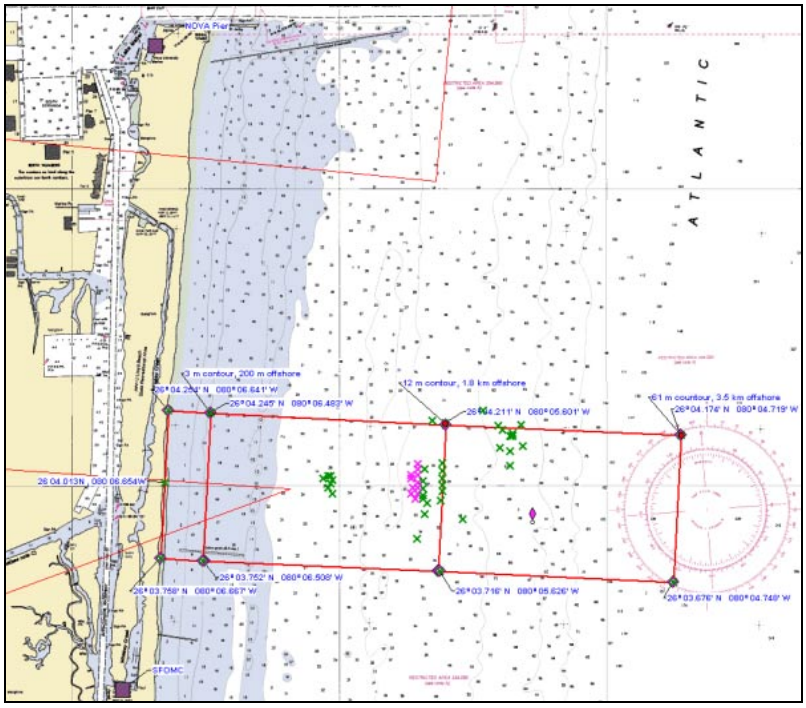

Figure 2. Existing SFOMC Mine Field

Figure 3. Example Mine-Shapes

Table 1. Targets Added Specifically for FBE-H

Target Name	Plant	Position	Water (Feet)	Mine (Feet)	Bottom Type	Serial # On unit	Picture Frame #
MK-6	26:04.689	80:05.050	74	38	Reef	98-20	16
MK-6	26:04.888	80:05.288	65	28	Sand	98-XX	15
MK-6	26:03.764	80:05.094	75	38	Sand	98-17	18
Reflector	26:04.711	80:05.353	65	64	Sand	N/A	19
Rockan	26:04.787	80:06.143	17	17	REEF	SNRK027	2 and 3
Rockan	26:04.706	80:06.158	19	19	REEF	SNRK024	4
Rockan	26:04.630	80:06.164	19	19	REEF	SNRK025	5
Rockan	26:04.560	80:06.168	22	22	REEF	SNRK026	6
Rockan	26:04.478	80:06.181	21	21	REEF	SNRK004	7
Manta	26:04.719	80:05.849	32	32	Sand	MT001	8 and 9
Manta	26:03.823	80:05.175	58	58	Sand	MT001	Series
Manta	26:04.613	80:05.856	32	32	Sand/Reef	MT004	10
Manta	26:04.498	80:05.869	33	33	Sand	MT008	11
Manta	26:04.393	80:05.877	33	33	Rock	MT015	12
Manta	26:04.284	80:05.883	34	34	Sand	MT016	13
Manta	26:04.430	80:05.354	68	68	Sand	MT017	14
TowBody	26:04.367	80:05.509	62	62	Sand/ruble	101	Series
AirConditionHood	26:04.874	80:06.028	23	22	Hard	102	Series
AL_TailSection	26:04.323	80:06.114	28	28	Hard	103	Series
Steel_TailSection	26:04.323	80:06.114	28	28	Hard	106	Series
LightCover	26:04.970	80:06.117	19	19	Hard	105	Series
AL_TailSection	26:04.672	80:05.498	56	56	Sand	104	Series
MPD	26:04.789	80:06.440	16	16	Sand	MPD1	1 roll 2
MPD	26:04.751	80:06.444	17	17	Reef	MPD2	2 roll 2
PDM-2 01	26:04.466	80:06.455	17	13	Rubble	PDM-2-207-VSW	3 roll 2
PDM-2 02	26:04.427	80:06.457	17	13	Sand	PDM-2-211-VSW	4 roll 2
PDM-2 03	26:04.390	80:06.459	20	16	Sand	PDM-2-214-VSW	5 roll 6
PDM-2 04	26:04.122	80:06.318	14	11	Reef	PDM-2-216-VSW	6 roll 2
250 lb Bomb	26:03.810	80:05.614	56	55.5	Sand Patch	06-00-07	

Color Key	
	Practice
	Test Field
	Removed
	Unit Pair

ENVIRONMENTAL COMPLIANCE AND SAFETY

The Navy's South Florida Testing Facility (SFTF) has overall responsibility for the control, safety, and environmental compliance of all operations on the SFOMC range. As a consequence, environmental compliance has been an ongoing activity with updates and modifications made as new projects emerge. The environmental documentation and procedures regarding the FBE-H operation involved a combination of existing range documentation as well as several additional assessments specific to the project. SFTF efforts focused on three areas:

- Marine Species: Since a major facet of the operation involved the use of sonars and other active acoustic devices, the potential impacts to marine species resulting from these systems had to be assessed. SFTF personnel reviewed the entire operation in accordance with the National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). This review culminated in the development of a Memo to File which included the types of operations involved, the physical characteristics of each operation (sonar source levels, frequencies, duty cycles, etc.), the applicable environmental regulations, and the potential for impact resulting from these activities. The review used information from the various participants to determine if there was a significant potential for impact to marine resources in the test area. The main species of interest were the marine mammals in the area (primarily dolphins) and nesting sea turtles along the beaches bordering the test areas.

- Sea Turtles: The SFOMC range contains beaches used by nesting sea turtle species, all of which are either threatened or endangered. Beach activities, including crawler operations and small boat launching, were assessed for their impact on sea turtles. In order to maximize the avoidance of sea turtle nests, all marked nests were located using GPS and added to a GIS chart of the operational areas. This provided a graphical representation of the areas and nests, and allowed quick identification and correction of potential impact issues. Using this tool, along with nest avoidance procedures, the operations were successfully located in areas without nests, avoiding any potential nest disturbances.

- Public Safety: In addition to the environmental concerns there was also a concern for the safety of the swimming public during the testing of AUVs and underwater crawler vehicles on the range. SFTF provided range safety that consisted of a Range Safety Officer located at the SFTF range house. The safety officer, on a specific safety radio frequency, controlled a number of safety picket boats capable of interdicting and warning recreational boaters about the surface and underwater operations being conducted. Because the underwater crawler vehicles typically operated in less than 10 feet of water and because some of the AUVs could also operate near shore, SFTF developed a procedure for restricting access to the beaches during near-shore range operations to eliminate the possibility of a vehicle to swimmer interaction. This procedure was effected with the management and staff at John Lloyd State Park. Because the park has over 2.5 miles of public beach, many of the beaches did not require closure for these operations and little inconvenience was felt by the visiting public.

SFOMC OPERATIONS CENTER AND LOGISTICS SUPPORT

The FAU's SeaTech Facility was the primary SFOMC site for command, control and participant support. For command and control, the SeaTech Auditorium was reconfigured to provide space for the

following: Test Director with a communications station; operations and communications desks for each of the participating groups; range, site, and real-time environmental data; AUV data processing systems; and a daily operational and press/VIP briefing area.

In addition to the SFOMC shore-side and facilities assets that supported the FBE-H dress rehearsal, FAU and the Navy supported at-sea testing with a number of small craft and research vessels. Small boat support ranged from supplying three RHIBS, providing picket boats for range safety and security, and water taxi/shuttle craft for personnel and equipment transfers. Three research vessels were also utilized for operations. This included the 34 foot R/V OCEANEER IV, the 95 foot M/V BECKER, and the 65-foot R/V STEPHAN. The STEPHAN was the primary support vessel for the at-sea exercises. It supported the deployment and recovery of the AUVs, acoustics/interoperability testing, and deploying and recovering acoustic beacons and other bottom mounted instrumentation.

The operation was a success. All of the AUV groups gained significant real world operating experience within a true natural laboratory. In addition, the event received significant VIP and media attention.